COMMUNICATION

A Historical Review of the Reconstruction of Hand Injuries

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The evolution of hand trauma surgery can be attributed to 3 major factors: war, industrialisation, and technological advancement. Its roots are shared with head and neck reconstructive methods.

Early Indian and Greek cultures made enormous contributions to the field of plastic surgery. Shushruta (around 1000–800 B.C.) laid the foundation of plastic surgery by performing the pedicled flap for nose reconstruction, which has been documented along with his other accomplishments in the *Shushruta Samhita*. In Egypt in 250 B.C., Herodotus performed cadaveric dissections to better understand human anatomy. The history of the Roman Empire also documents the use of random and pedicled flaps for lip, nose, and ear reconstruction. Barriers of distance and language served as a limiting factor, and advances in plastic surgery came to a standstill during the Dark Ages.

The end of the Dark Ages led to a surge in plastic surgery procedures, with a description of the nerves carried out by Gugliemo da Saliceto (1210–277 A.D.), and a description of the circulatory system by Mondino de Liuzzi (1270–326 A.D.) in which it was visualised by injecting coloured dye. In Italy, Antonio Branca also propagated the technique of a forehead flap, using the techniques described by Shushruta for the nose. The first documented distant flap reconstruction of the nose by a flap harvested from the upper arm was done by Antonio Branca, but it was Gaspare Tagliacozzi (1545–1599 A.D.), an anatomy professor at the University of Bologna, who published the technique. The advent of the printing press led to the further spread of the work of these pioneering surgeons. William Harvey established the concept of arterial and venous flow through his tourniquet experiment, as described in his 1628 book. The foundation laid by the surgical fraternity during this period led to the development of flap reconstructive techniques.

The Industrial Revolution, which started in approximately 1770, accelerated the rate of knowledge dissemination. Although it had been disfavoured, debridement of wounds came to be preferred over amputation during World War I under the influence of Antoine Depage. With the advent of general anaesthesia, lengthy procedures could be carried out more effectively. Sir Joseph Lister's aseptic technique and the discovery of carbolic acid use led to an increase in the success rate of procedures. Due to the collective impact of triage, wound dressings, asepsis, antibiotics, and blood typing, new-found hopes of survival by means of reconstructive procedures emerged. The post-World War I time period marked the advent of salvage procedures for the upper limb. Wood referred to the works of Tagliacozzi and performed an axial pattern groin flap for upper extremity burn contracture. Manifold advances occurred, from Carl's (1897) use of the thoracoepigastric flap for degloved thumbs to the osteoplastic reconstruction of digits using distant flaps by Albee in 1919. Tubed pedicled flaps were introduced by Vladimir Petrovich Filatov in 1916 and Sir Harold Gilles in 1917. The time was ripe for the consolidation of knowledge from past and current experiences, as done by the so-called father of hand surgery, Sterling Bunnell, after World War II. An Italian surgeon, Ettore Leali, proposed the V-Y advancement for a volar fingertip injury in 1935, which laid the foundation for the later Atasoy flap and the Kutler flap. Edwin DeJongh described a bipedicled advancement for fingertip injuries in 1942 in factory workers.

The end of World War II marked the beginning of first-generation intrinsic hand flaps. Cronin in 1945 and Gudin and Pangman in 1950 reported the cross-finger flap. Similarly, Flatt in 1955 popularised Gatewood's previously reported thenar flap. The second generation brought axially-based flaps, with the first dorsal metacarpal artery flap by Hilgenfeldt in 1950, later modified by Foucher, Holevich, and Braun. Littler and Moberg developed flaps for digital defects in parallel in 1960. These second-generation flaps and many more documented by various surgeons over time proved their worth by being more robust with a greater potential for distance.

In the 1960s, the realm of plastic surgery took a momentous turn with the advent of free microvascular tissue transfer. Malt and McKhann performed the first successful re-implantation of the forearm in 1962, while Kasdan and Kleinert successfully revascularised an amputated thumb in 1963. Chinese surgeons performed the first microvascular toe-to-thumb transfer in 1965, but this line of research suffered from political isolation. In 1968, it was publicised by Cobbett. In Japan, Harii performed the first free fasciocutaneous flap transfer from the groin to the upper extremity in 1973. The first free musculocutaneous transfer was done in China in 1976. The chimeric flaps introduced by Hallock in 1991 provided cover for mangled ex-

tremities with composite tissue requirements. Venous flow through flaps was accomplished by flaps simultaneously designed by Honda and Tsai for small hand defects in the 1980s. The latest evolutionary point, a composite allograft, was first attempted in 1964 but was successfully accomplished in 1988. The progression of microvascular free tissue transfer superseded the development of pedicled axially-based fasciocutaneous, musculocutaneous, and muscle flaps of the upper extremity.

The third generation of flaps provided innervated results. Joshi developed sensate homodigital island flaps from a dorsal transposition flap. Heterodigital island flaps were introduced under the name of Fillet flaps by Littler and Moberg. With the discovery of the angiosome concept, freestyle as well as perforator-based flaps came into being in the late 1980s. In 2003, Wei and Mardini also introduced the freestyle technique for dissecting the vasculature of perforators in a retrograde fashion to minimise donor site deficits.

The first short-term success in human hand transplantation occurred on September 23, 1998 in Lyon, France, in a procedure performed by Prof. Nadey Hakim (UK) and Prof. Jean-Michel Dubernard from France on a patient from New Zealand who had lost his hand in an accident while in prison. The first hand transplant to achieve prolonged success was directed by a team of Kleinert Kutz Hand Care surgeons on January 14, 1999.

Although tremendous advances have occurred, much room for progress remains, especially for conditions such as cicatricial burn scarring, which leads to joint destruction and impaired tendon gliding, and has yet to be managed effectively. Similar limitations are encountered in cases of severely mangled limbs. It may be hoped that the current knowledge of surgical methods and access to ever-evolving technology may lead to better understanding, as the clinical outcome of reconstructions will always be the major driving force for technical developments.